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TREE HOPPERS AND THEIR CONTROL IN THE ORCHARDS OF THE PACIFIC NORTHWEST

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INTRODUCTION [1]

For many years there has been, in different parts of the country, a peculiar injury to the young wood of fruit trees caused by several species of insects commonly known as "tree hoppers." In the Pacific Northwest this injury has been especially common in orchards in which alfalfa is grown as a cover crop, and has become serious enough to require control measures for its suppression. Alfalfa is a favorite food plant of these insects, and they are more or less numerous wherever it is grown in orchards. Injury also often occurs along the edge of fruit-tree nurseries which are adjacent to fields of alfalfa, and throughout newly planted orchards which have been set out in land previously occupied by alfalfa and in which occasional alfalfa plants still persist. Though the nature of the injury is such that the loss can not be easily given a monetary value, the damage is nevertheless considerable.

KINDS OF TREE HOPPERS

Until quite recently tree hoppers in orchards in the Pacific Northwest have been referred to indiscriminately by both entomologists and orchardists as "the buffalo tree hopper." Investigation has shown, however, that about 15 [2] different species are present in the orchards, and several additional species have been found in other

[1] The field observations and experiments upon which this circular is based were made, for the most part, at Yakima, Wash., at various times and incidental to other work during the years from 1923 to 1926, inclusive.

[2] *Ceresa albidosparsa* Stål, *C. basalis* Walk., *C. borealis* Fairm., *C. bubalus* Fab., *C. femorata* Fairm., *C. taurina* Fitch, *Stictocephala gillettei* Godg., *S. inermis* Fab., *S. pacifica* Van D., *S. wickhami* Van D., *Campylenchia latipes* Say, *Glossonotus univittatus* Harr., *Heliria rubidella* Ball, *Publilia modesta* Uhler, and *Telamona barbata* Van D.

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places. Of this number, however, only the buffalo tree hopper (*Ceresa bubalus*) (fig. 1, A), the green-clover tree hopper (*Stictocephala inermis*) (fig. 1, B), the basal or dark-colored tree hopper (*C. basalis*) (fig. 1, C), are thus far recognized as common enough to be considered of economic importance in that area, although the crested brown-mottled tree hopper (*Heliria rubidella*) has been found in considerable numbers on apple trees in the Wenatchee district [3] and rarely in the Yakima Valley, Wash., and in southern Idaho.

Another species, *Stictocephala gillettei*, which has no common name, is an important species in Utah,[4] but this species is unknown in the Yakima Valley.

As all these different kinds of tree hoppers have so many points in common they are here treated for the most part as one group, although any important differences among the three most common species are pointed out.

DISTRIBUTION

The several species of tree hoppers considered here are found in a number of the Canadian Provinces and in most of the States except those in the extreme South, though one species [5] is found in Florida. In the Pacific Northwest their distribution is generally coincidental with the use of alfalfa as a cover crop in orchards.

NATURE OF INJURY

The injury caused by the tree hoppers is due to the weakening effects of their oviposition wounds on the fruit-tree twigs rather than to their feeding, which causes comparatively little damage. Most of the oviposition scars are found on the upper surfaces of the twigs growing from the lower branches, especially on those which hang down into or toward the alfalfa. Very rarely is injury found more than 6 or 7 feet above the ground. The three more harmful species cause rather distinctive types of injury, which are discussed in the order of their importance in the Northwest.

A much roughened, ragged appearance (fig. 2) is given to the twigs by the scars caused by the green-clover tree hopper. The incisions are cut well into the bark, but there are numerous shallow, supplementary cuts near by, which cause the bark to curl away from the main incision. This injury hinders the proper functioning of the bark, and retards the growth of the twig. The green-clover tree hopper lays its eggs entirely in 1-year wood and the oldest of the current season's growth.

Oviposition wounds in the form of deep, distinct, clean-cut longitudinal slits (fig. 3), a few of which are sufficient to cause the terminal portion of the twigs to die (fig. 4), are made by the basal, or dark-colored tree hopper. This tree hopper oviposits in the wood formed during the current season, sometimes well out toward the tips. Often the injury by this species begins where that caused by

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[3] YOTHERS, M. A., WEBSTER, R. L., and SPULER, A. HELERIA RUBIDELLA BALL. COMPARATIVELY UNKNOWN MEMBRACID BECOMES ABUNDANT AND PROBABLY INJURIOUS IN ORCHARDS IN THE WENATCHEE, WASH., DISTRICT. (Scientific Note) Jour. Econ. Ent. 22: 269. 1929.

[4] SORENSON, C. J. TREEHOPPER INJURY IN UTAH ORCHARDS. Utah Agr. Expt. Sta. Bul. 206, 18 p., illus. 1928.

[5] *Stictocephala inermis.*

the others leaves off. Both types of wounds are shown intermingled on the same twigs in Figure 5, A.

The buffalo tree hopper places its eggs in pairs of more or less parallel longitudinal cuts.

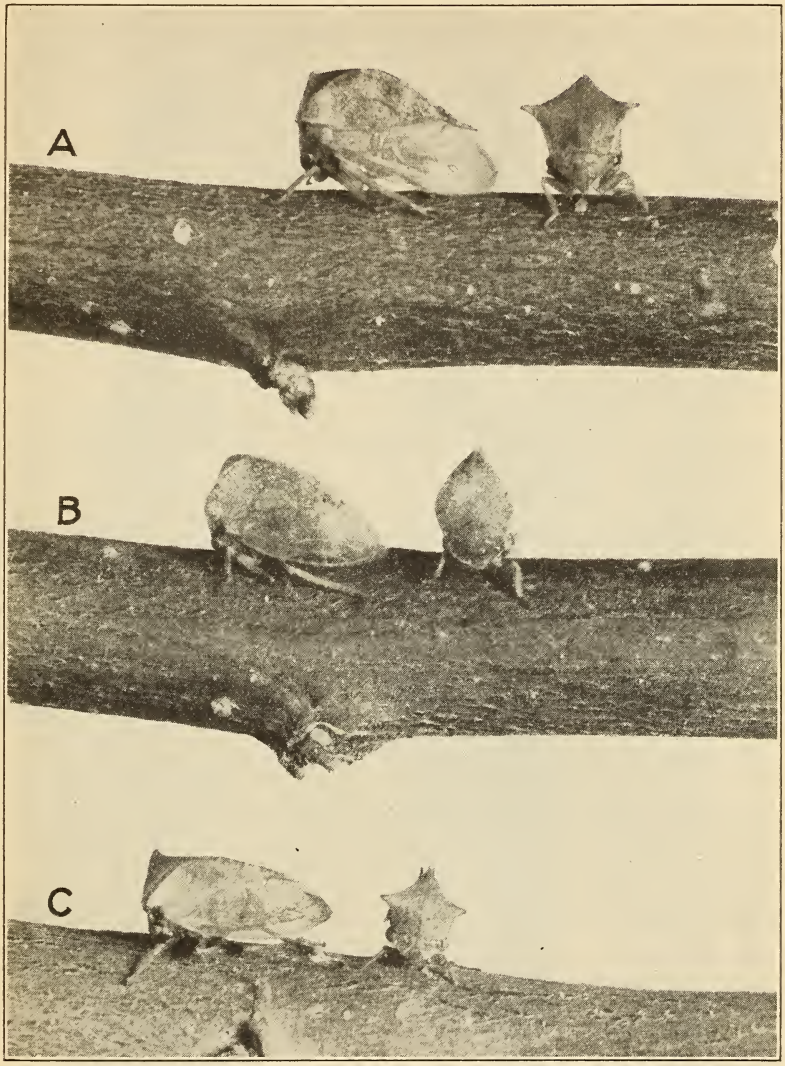

FIGURE 1.—A, Buffalo tree hopper, side and front views; B, green-clover tree hopper; C, basal or dark-colored tree hopper. × 3

Oviposition wounds by tree hoppers furnish suitable entrance for the woolly apple aphid,[6] many colonies of which find lodgment in them. (Fig. 5, B.) Overwintering eggs of the apple aphid[7] are also often present. Occasionally the oviposition scars so weaken

[6] *Eriosoma lanigerum* (Hausm.). [7] *Aphis pomi* DeG.

the twigs that they subsequently break, with the weight of the fruit out beyond them.

FOOD AND OVIPOSITION PLANTS

In the orchards of the Pacific Northwest the tree hoppers feed almost exclusively upon alfalfa, though occasionally upon sweet clover.

FIGURE 2.—Apple twigs showing the characteristic shaggy, roughened appearance due to the oviposition wounds of the green-clover tree hopper: A, Natural size; B, × 3

They are known, however, to feed upon grass, red clover, and other forage plants. In rare cases the newly hatched nymphs have been seen feeding upon apple and pear buds, wild mustard, and dande-

lion. Nightshade placed in a rearing cage was so girdled that the top of the stems died beyond the scar.

The tree hoppers have been found to deposit eggs in the following trees: Apple, pear, peach, willow, locust, and poplar. (Fig. 6.) Cherry and prune trees appear to be nearly immune. In a num-

FIGURE 3.—Apple twig showing leaf clusters nearest the tip and a number of oviposition wounds of the dark-colored tree hopper in the live wood below the foliage. Natural size

ber of instances cherry and prune trees growing in the oldest of seriously infested apple orchards in alfalfa cover crop showed no oviposition scars.

GENERAL DESCRIPTION OF TREE HOPPERS

These insects are from 7 to 10 millimeters (one-fourth to three-eighth inch) in length and from 3 to 6 millimeters in width, more

FIGURE 4.—Terminals of apple twigs killed by oviposition wounds (*a*) of the dark-colored tree hopper. Three-fourths natural size

or less triangular in shape, whether viewed dorsally or ventrally, or from the side, and with their greatest height and width at the thorax and tapering gradually backward. (Fig. 1; fig. 9, G and H.) The upper covering of the tree hoppers is composed of membranous wings and a hard shell, the pronotum. Viewed from in front they

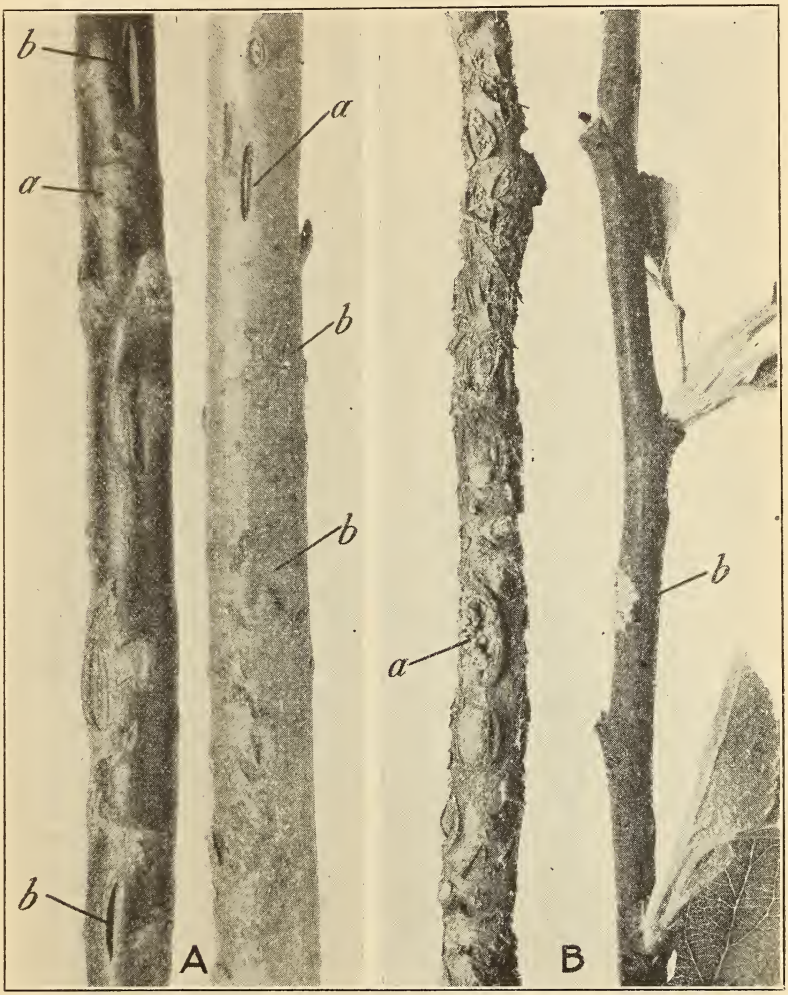

FIGURE 5.—A, Intermingling of oviposition wounds of the green-clover tree hopper (*a*) and the dark-colored tree hopper (*b*), slightly enlarged; B, colonies of the woolly apple aphid in an old oviposition scar (*a*) and in a new scar (*b*), natural size

have an odd angular appearance whether they have the pronotal horns (fig. 1, A and C) or no horns (fig. 1, B). The pronounced horns projecting from either side of the pronotum are the characteristics which give the buffalo tree hopper its name owing to its fancied resemblance to the bison or buffalo.

The three species most common in orchards of the Pacific Northwest may be distinguished as follows: The buffalo tree hopper, *Ceresa bubalus* (fig. 1, A) is the largest of the three and has projecting pronotal horns. The dark-colored tree hopper, *C. basalis* (fig. 1, C), is the smallest of the three species and also has pronounced pronotal horns, but it is darker generally and black ventrally, with

FIGURE 6.—Oviposition wounds of the dark-colored tree hopper: A, In pear; B, in willow; C, in peach; D, in locust; E, in apple. Natural size

short hairs on the pronotum, especially in front. The green-clover tree hopper, *Stictocephala inermis* (fig. 1, B), has no pronotal horns.

LIFE HISTORY OF TREE HOPPERS

HATCHING OF EGGS

Hatching starts in early April for most species and continues until early May. The eggs of the dark-colored tree hopper (fig.

7. *a*, *b*) hatch later than those of other species, beginning to hatch in early May about the time those of the green-clover species (fig. 7, *c*) and the buffalo tree hopper are through hatching. Most hatching takes place on warm, humid mornings, few young nymphs emerging in the afternoon and none at any time when the temperature is below 50° F. On warm mornings, during the hatching period, thousands of the tiny, white nymphs are often seen emerging from their eggshells in the scars in the bark of twigs (fig. 8, A), water sprouts, and 1-year-old trees. Upon hatching they fall almost immediately to the ground or upon whatever plants are present in the orchard. After the eggs have hatched numerous empty, white eggshells remain protruding from the scars. (Fig. 8, B.)

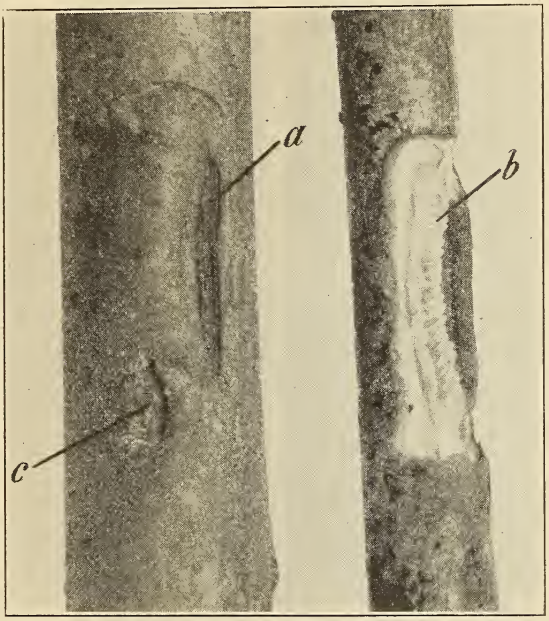

FIGURE 7.—Egg pouches of the tree hoppers: *a*, Pouch of the dark-colored tree hopper; *b*, a pouch of the same with the bark removed to show the eggs; *c*, egg pouch of the green-clover tree hopper. × 3

NYMPHAL STAGES

After falling to the alfalfa or other plants in the orchard, the young nymphs feed upon these plants, pass through five nymphal stages (fig. 9), and become adult in late June or early July. Throughout the nymphal stages they live by sucking the juices from these plants. They are rarely observed during these stages, since they hide themselves at the very base of the plant upon which they are feeding. They prefer the semidark humid conditions prevailing in the center of alfalfa crowns. Fifty days and ninety days have been recorded as the two extremes for the length of the combined nymphal stages. The average length of time is probably from about 60 to 80 days. During the nymphal stages the insects are of the same general shape as they are in the adult stage, but instead of the

hard shell covering they have many bristly spines decorating their backs and many small hairs covering their bodies. (Fig. 9, B–F.) They are of a creamy white to dark-brown color, and have a more or less mottled greenish appearance.

ADULT STAGE

Adults (fig. 1; fig. 9, G and H) make their appearance in late June and in July and are present until the last of September, although few are seen after the middle of September. The insects

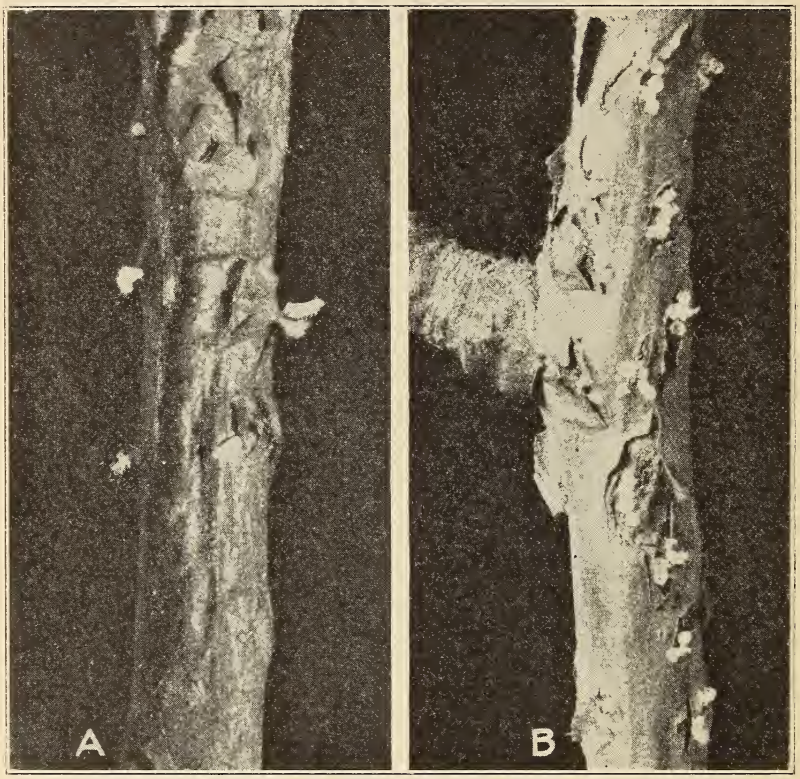

FIGURE 8.—A, Tree hoppers (*Stictocephala inermis*) hatching from eggs deposited in wounds in apple twig; B, empty eggshells protruding from the egg pouches or oviposition wounds. × 2

live about two months in the adult stage. During this time they feed to a limited extent upon the alfalfa or other cover crop, but their feeding is apparently of so little consequence, as is the case with the nymph, that no injury is attributed to it.

The adults fly somewhat, especially when disturbed, and in this way become disseminated over the orchard and from one orchard or alfalfa field to another.

OVIPOSITION

The adults spend most of the daytime on the fruit-tree twigs in which the females lay their eggs. Eggs are deposited from late in

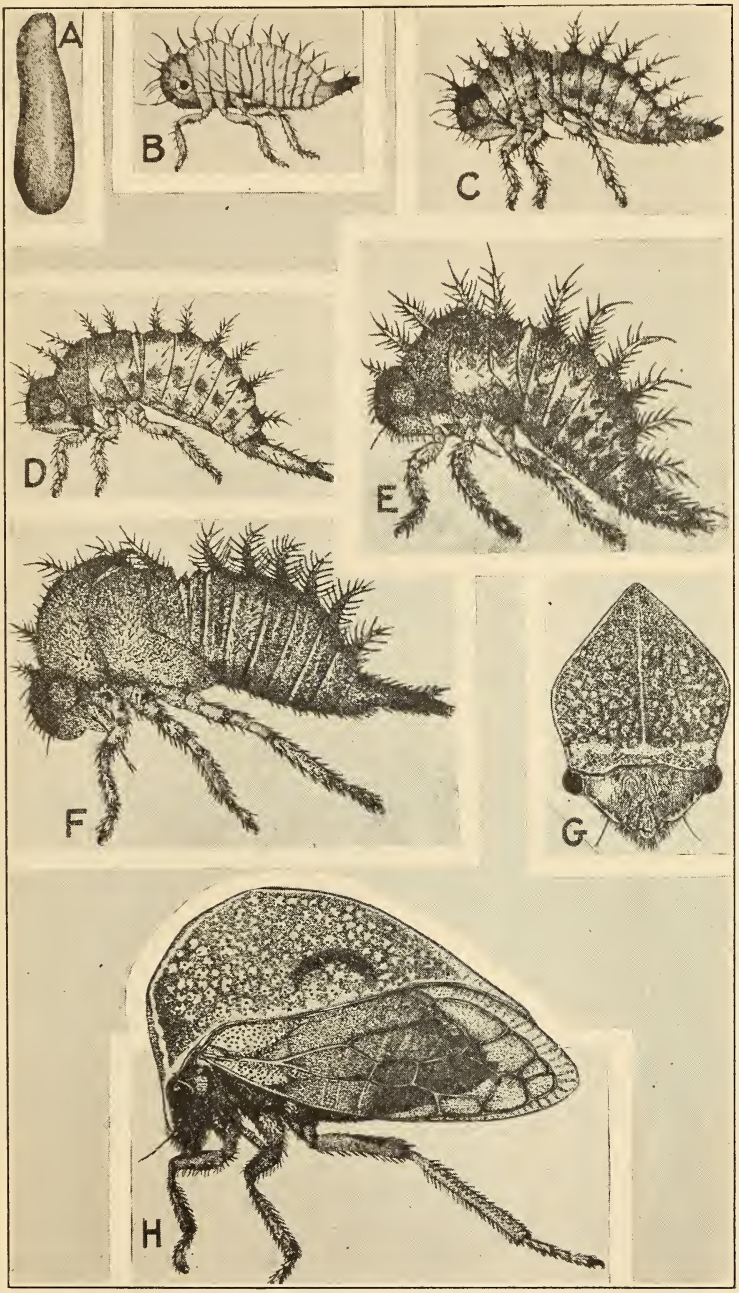

FIGURE 9.—Life-history stages of the green-clover tree hopper, which is fairly characteristic of most of the species mentioned: A, Egg, × 15; B–F, first to fifth nymphal stages (B, × 20; C, × 14; D, × 12; E, × 10; F, × 9); G, adult, front view, × 7½; H, adult, side view, × 7½

July to the middle of September. With her ovipositor the female cuts the slit into which she deposits her eggs, one at a time, until the slit is filled. All species except the dark-colored tree hopper deposit an average of about 6 eggs per pouch, while that species deposits an average of nearly 20. (Fig. 7, *b*.) Probably 100 to 200 eggs in all are deposited by a female of any of the species.

HIBERNATION

The insects overwinter in the egg stage in the outer wood of fruit trees and possibly in other trees and shrubs. As much as nine months of the life cycle may be passed in the egg stage, since the earliest eggs are deposited by the middle of July and the latest hatching does not occur until early in May of the following year.

NATURAL ENEMIES

Two species of parasites have been reared from the eggs of the green-clover tree hopper (*Stictocephala inermis*).[8] Two determined species of spiders[9] and other undetermined species, an ant,[10] at least two species of lady beetles,[11] several undetermined species of syrphus-fly larvae. and predatory lacewing flies[12] have also often been observed devouring the hatching nymphs of this species. Certain mites are known to destroy the eggs of both *Stictocephala inermis* and the dark-colored tree hopper, *Ceresa basalis*.[13] Birds and toads are also known to feed upon the tree hoppers both in their nymphal and adult stages.

PREVENTIVE AND CONTROL MEASURES

CLEAN CULTIVATION

Since these insects are dependent in their developmental stages upon the cover crop, such as alfalfa or sweetclover, or upon weeds growing in the orchard, it is obvious that the removal of these from the land before planting the orchard and keeping them out continuously thereafter would be one of the surest methods of control.[14]

It has been found that clean-cultivated orchards are always free of tree-hopper injury and that injury is most serious in orchards in which alfalfa is grown as a cover crop. Under the cultural conditions prevailing in orchards in the arid regions of the Pacific Northwest, however, it is inadvisable to keep an orchard clean cultivated although the land should be freed of any such crop as alfalfa before the trees are set out.

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[8] *Gonatocerus* sp., *Tetrastichus* sp.
[9] *Philodromus minuta* Bks. and *Dendryphantes militaris* Hentz.
[10] *Formica fusca fusca* var. *argentia* Wheeler.
[11] *Adalia bipunctata* L. and *Hyperaspis quadrivittata* Lec.
[12] Genera Hemerobius and Chrysopa.
[13] Genus Achorolophus, family Erythraeidae.
[14] References to food habits and control do not apply to the crested, brown-mottled tree hopper (*Heliria rubidella*), which occurs in considerable numbers in the Wenatchee Valley, Wash., since this species apparently feeds throughout its entire nymphal period upon the fruit trees and is not dependent upon cover crops for its sustenance. Since this species also deposits its eggs in the fruit-tree twigs, however, it is probable that all methods of control other than clean cultivation, especially the use of dormant oil sprays, would prove equally adequate for it.

Sweetclover (*Melilotus* sp.), which is sometimes used in place of alfalfa (*Medicago* sp.) as an orchard cover crop, would doubtless prove preferable to alfalfa from the standpoint of tree-hopper control, as it lasts only two seasons, is less suitable than alfalfa for tree-hopper food and protection, and perfectly clean cultivation is entirely practicable following it.

PRUNING AND COLLECTING

Another control method which has been advised is to prune out and destroy infested twigs. This is practicable to a limited extent where only occasional twigs are infested, but to cut off all infested twigs containing eggs would mean in many cases a very severe cutting back of nearly all lower twig terminals, or, in case of 1-year-old or 2-year-old trees, their complete destruction.

The use of hopperdozers to collect the insects has been suggested, but this has been found impractical in the cover-cropped orchards.

SPRAYING

The use of oil or nicotine sprays against the nymphs while they are feeding on the cover crop has been found to give but little if any control.

For controlling tree hoppers once they have become established in an orchard, spraying the trees with an oil spray, when pruning or clean cultivation is impracticable, has been found effective in killing most of the eggs.[15] Though 100 per cent of the eggs are rarely destroyed with any spray treatment, enough of them are killed to reduce the infestation to a minimum. Dormant sprays containing 4 per cent or more of oil, as used for the San Jose scale [16] or the fruit-tree leaf roller,[17] have been found to kill from 70 to 100 per cent of the eggs when properly applied. Since lime-sulphur has been found of little value in destroying tree-hopper eggs, it will be necessary to make a special application of an oil spray to control these insects in lime-sulphur-sprayed orchards or in orchards which would otherwise be unsprayed. Extra applications of dormant oil sprays for tree-hopper control are not necessary, however, since the regular applications of these sprays will suffice if special care is taken to wet thoroughly the infested twigs, most of which hang low in the case of bearing trees and are often missed in spraying for the leaf roller and the San Jose scale.

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[15] YOTHERS, M. A. "TREEHOPPERS," NEW ORCHARD PESTS IN THE PACIFIC NORTHWEST. Wash. State Hort. Assoc. Proc. 20: 97–102. 1924.

[16] *Aspidiotus perniciosus* Comst.

[17] *Archips argyrospila* Walk.

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